

Nuclear + Renewable Energy = The Ideal Mix?

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ABSTRACT

Not much thought is given when flicking on the lights at home, but that energy travels from somewhere. Current energy production allows for modern luxuries like lights, TVs, and travel, but is also one of the biggest contributors to global warming. Given the problems the climate is currently facing it is vital to look out for the possible ramifications of certain power production. This thought process is crucial to keep in mind when deciding which source is best to run the world's electricity and power. Each of these sources has its own set of positive and negative aspects but the benefits must outweigh the costs. Through researching past articles and studies, a synthesized analysis of several forms of renewable energy will be produced. In addition to this, the following question will be answered: can nuclear energy's positives outweigh the costs and will it be the missing piece for sustainable energy? Looking into the background of the subject, it is known that nuclear energy is very reliable, powerful, and can be the base load which a power grid can be built on. A deeper investigation of how public opinion is largely affecting the ability for these power plants to be built, thus preventing the expansion and integration of nuclear energy, will also be included. This is a central topic as the only way to ensure that nuclear energy will be able to expand is to inform the population of its benefits and erase the negative connotation that comes with its name.

Introduction

The climate crisis has been an ongoing problem for the entire world's population and, as said by NASA, "while science tells us that climate change is irrefutable, it also tells us that it is not too late to stem the tide." A step towards the right direction would be to consider the energy needed for a cleaner future. Renewable energy is the key to getting started and it is an urgent one. Without it we are only emitting more fossil fuels and harmful gasses into the air, further generating contributors to the global warming process. As stated by the United Nations, "We now need to put them [renewable energies] to work, urgently, at scale and speed." Although all energy forms have their benefits, nuclear energy might just be the answer to the world's problems.

The history of nuclear energy has a checkered past, with its origin starting and ending a great war in 1945. Originally the research behind nuclear power was to create a weapon to end all wars, and from that mission, nuclear power was born. In 1953 the Atoms For Peace program was unveiled, devoted to developing peaceful nuclear technologies and from that program the first U.S. town was powered by nuclear energy in 1955. From the promise of "free energy" that nuclear energy could provide, the technology rapidly spread across the United States, and by 1980 there were around 253 operating nuclear power plants. Nuclear power had a very bright future until the three major industry accidents happened. After the first accident "Three Mile Island" occurred, public opinion soured towards nuclear energy, and new construction looked elsewhere for new power plants. From this accident the Nuclear Regulatory Commission (NRC) was formed to help better regulate the industry and promote a unified safety standard. Perhaps the most famous accident is Chernobyl in 1986. After this the most significant change came in the keeping and maintaining of safety regulations across the world. A different outcome arose from the Fukushima Disaster in 2011, as it was due to a natural disaster. From

this, nuclear power plants became safer by increasing the distance between reactors of the same plant, preventing an accident from worsening as one damaged reactor would not affect the other if it were farther away. Now, other than having improved power plants, there is also new nuclear technology known as a “small modular reactor” (SMR). SMRs are “advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit, which is about one-third of the generating capacity of traditional nuclear power reactors. SMRs, [...] can produce a large amount of low-carbon electricity”¹ while being small and modular (therefore able to be manufactured and transported). The reason they are so efficient is due to their size and the fact that they can be suitable for areas that would not be able to support a standard power plant. This paper aims to showcase the forms of low carbon electricity generation, inform the public on the potential of nuclear energy, and give an overview of positives, negatives, costs, energy load share, and public opinion of each type of energy.

Solar Power

Solar power is a very popular way to create renewable energy and is used worldwide. Two of its most beneficial aspects are that they have diverse applications and are extremely easy to install. Whether they are put on a house, school, or office building they can easily catch sunlight to transform into energy. However, a major drawback with solar power is the fact that it is completely weather dependent. If there is a large cloud cover one day, the panels will not be able to catch as much sunlight and therefore not be able to create as much power as perhaps some other types of energy. This would mean that in order for solar power to create as much electricity as possible, it would have to be situated in a location accessible to a large amount of sunlight. Another drawback is the fact that it is the type of energy that has the least energy load share, meaning that it has so far created the least amount of energy in the United States. In total 115 billion kWh, which is only 2.8% of the total energy. Like most other energy types its startup costs are high while its maintenance costs are relatively low. Despite the negatives involved in the usage of this type of energy, it is regarded quite highly and only 9% oppose it, making it the most favored energy source.²

Wind Power

Wind power has also been used quite a lot in the United States in the last years as a renewable energy source. This may be because of a few of its attributes. For example, once installed, wind turbines run themselves and do not need much maintenance. Another plus is that wind power doesn't disrupt land surrounding it, seeing as it does not take up much space at all. However, although it is not dangerous to surrounding land, it can be dangerous for wildlife, especially birds who might get caught in the blades. Wind power is also a large cause of noise pollution. This may not seem like a tremendous complication in comparison to its advantages, yet noise pollution can have many harsh effects that many are not aware of. For example, “According to the National Park Service (NPS) in the United States, noise pollution has an enormous environmental impact and does serious damage to wildlife. Experts say noise pollution can interfere with breeding cycles and is even hastening the extinction of some species.” Its unreliability is also a great flaw as strong wind is required to make the blades turn, generating electricity, which can present some difficulties in certain areas of the world. According to the U.S. Energy Information Administration, “Favorable sites include the tops of smooth, rounded hills; open plains and water; and mountain gaps that funnel and intensify wind.” These are very specific location requirements that are not encountered everywhere, therefore making it difficult to implement this type of energy ubiquitously. However, notwithstanding its limitations, wind power has a decent load share in the United States out of the

¹[https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs#:~:text=Small%20modular%20reactors%20\(SMRs\)%20are.of%20traditional%20nuclear%20power%20reactors](https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs#:~:text=Small%20modular%20reactors%20(SMRs)%20are.of%20traditional%20nuclear%20power%20reactors).

² <https://www.pewresearch.org/science/2016/10/04/public-opinion-on-renewables-and-other-energy-sources/>

renewable energies, with a total of 380 billion kWh (9.2% of total)³. Perhaps this is because of the low opposition rate of the population, as only 14% were said to oppose wind power in the United States.⁴

Hydropower

An additional renewable energy source is hydropower, which uses water to produce electricity. Hydropower is both very reliable and inexpensive in the long run. The reason the constructions have been labeled as reliable is due to the fact that they “can dispatch power to the grid immediately when all other energy sources are inaccessible, they provide essential back-up power during major electricity disruptions [...]”⁵ Due to the fact that, although startup costs are relatively high, operation costs are quite low, hydropower is also known to be inexpensive long-term. The flip side to these assets is that the energy source can adversely affect the environment and fully relies on local hydrology. Dams have a negative effect on the environment, especially in construction. This is because when a dam is built, new power lines need to be installed which could potentially disrupt its surroundings. In addition to this, “When dams flood areas, it creates sections of still or stagnant water that kills vegetation which emits greenhouse gasses as it rots.”⁶ Stopping the flow of water will also affect the habitat of fish in the water and disrupt their migration as well. Furthermore, hydropower is dependent on its local source of water and therefore would need to be placed in an area in which a large amount is available. These facts skew the public opinion of many citizens to the opposing side. A study on the energy load share states that hydropower produces 260 billion kWh, which is 6.3% of total power in the United States. This is a relatively high number on the spectrum yet not as high as some other types of energies.⁷

Nuclear Power

Finally, the last energy source that will be discussed is nuclear power. Nuclear power is an energy source used to create electricity through fission. The fission of uranium atoms from nuclear fuel produces thermal energy, which is used to heat up water. The water then turns into steam which creates mechanical energy by spinning the turbine. The mechanical energy in this turbine is then transformed into electric energy. Once the steam has passed through the turbine it is then cooled down again and transformed back into liquid water. This cycle repeats when the water is brought back to the reactor and later on transformed into steam again. The process allows for the generation of carbon free energy. Although masked by the public’s opinion of it, nuclear energy has many positive attributes. Such as, high fuel to power output ratio, its extreme reliability, and its absence on fossil fuels. The fuel to power output of nuclear power plants is tremendously high as “It has the capacity to meet city and industrial needs with just one reactor.” This is extremely beneficial as not many power plants would have to be built for the electricity to power a grid, therefore creating a more cost effective and space saving solution. Reliability is vital when working with an energy source, and nuclear power is one of the most reliable. Conserve Energy Future states that, “A nuclear power plant when in the mode of producing energy can run uninterrupted for even a year and more without interruptions or maintenance, making it a more reliable source of energy.” Perhaps one of the most considered benefits is the fact that nuclear power in no way relies on fossil fuels. This is important because its production “isn’t influenced by fluctuating oil and gas costs.” However, one of the biggest drawbacks of nuclear energy is the fact that uranium, which is the basis of the

³ <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>

⁴ <https://www.pewresearch.org/science/2016/10/04/public-opinion-on-renewables-and-other-energy-sources/>

⁵ <https://www.hydro.org/waterpower/why-hydro/reliable/>

⁶ <https://kiwienergy.us/pros-and-cons-of-hydroelectric-energy/>

⁷ <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>

production of electricity in a plant, is finite. This is the reason why nuclear power is not labeled as renewable. Although there is uranium that will last for around another 80 years⁸. Whilst it can not be called renewable, it can certainly be called recyclable as the waste can be reprocessed and recycled to use again. For the time being, nuclear energy has one of the biggest energy load shares in the nation, with a total of 778 billion kWh, making 18.9% of total. Also, like many others, the startup energy costs of nuclear power is high yet becomes low for operation costs. The biggest obstacle in building nuclear plants is not due to its drawbacks, but mostly due to public opinion. Around 54% oppose the making and maintaining of nuclear power plants in the United States.⁹ This is mostly because of past accidents that were mentioned before, and the fact that people still believe they are a common occurrence. This public opinion has had heavy consequences on the ability for new plants to be built. It is easy for many to fall into the trap of thinking that nuclear energy is “dangerous,” while only bearing in mind the accidents that occurred. As stated by the International Atomic Energy Agency, “They were [...]serious situations, but fearful reporting has contributed to misinformation about what happened and about nuclear more generally, which has only made the anti-nuclear imagery stronger.” The accidents were not as bad as most made them out to be and therefore the construction of power plants should not be decreased just because of misinformation.

Conclusion

Each energy has both positive and negative sides to it that can be assessed, yet how do they all compare to each other? To start, hydro, solar, and wind power all have a similar problem when it comes to strict location requirements. Meaning that they need specific weather conditions in order to get the most electricity out of them. This is something that nuclear energy is free of as it does not need anything other than to be next to a body of water. One of the areas in which all of the researched energies show a similarity is the fact that they have both high startup costs and low operation costs. Taking into consideration all of the advantages that each type of energy provides while also reviewing the possible drawbacks is important to come up with the combination of energies that will help our world become greener, faster. Each and every one of these energies is needed to be able to reach this end goal and while most of these energies are represented around the world and have a high public opinion, nuclear power does not.

This is what is missing. With its large percent of total energy produced and reliability, nuclear energy will be the foundation that grants the use of other renewable energy sources. Through further promoting the benefits of nuclear energy, the tide of public opinion can be swayed, and a path to a perfect recipe to green success will appear. The only way to start changing the world’s opinion on nuclear energy is to start at the root, and help understand how nuclear power actually works and how beneficial it can be, by eliminating stereotypes and prejudice against it. With knowledge, flicking on the lights at home shouldn't be magic, and on the other side of those lights will be a renewable source of power. The only question left to ask is whether this will become a reality used to solve the world’s energy needs.

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⁸ <https://www.conserve-energy-future.com/pros-and-cons-of-nuclear-energy.php>

⁹ <https://www.pewresearch.org/science/2016/10/04/public-opinion-on-renewables-and-other-energy-sources/>

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